Effect of Electrolyte on Thermal and Electrochemical Performance of 18650-type Lithium Titanate Cell

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Lithium-ion cells using lithium titanate anode have drawn great attention in recent years for safe battery technologies. Compared to the most widely used graphite anode for lithium-ion battery, lithium titanate generally possess the advantages of superior thermal stability, higher rate for charging, negligible volume change and long cycle life.

Hong *et al.,* [1] and Manikandan *et al.,* [2] reported in detailed calorimetric and thermal characterization studies on various commercial type 18650 lithium-ion cells. In those studies, while the total heat generation was estimated using an accelerating rate calorimeter (ARC), internal resistance was obtained using both Galvanostatic Intermittent Titration Technique (GITT) and Electrochemical Impedance Spectroscopy (EIS). Furthermore, impedance spectroscopy data were analyzed by Distribution of Relaxation Time (DRT) method to extract exclusive details about various components of internal resistance.

Present study reports heat generation and internal resistance of 18650 type lithium-ion cells using lithium titanate (LTO) as anode [3] and $LiNi_{0.33}Mn_{0.33}Co_{0.33}O_2$ (NMC) as cathode (Targray SNMCO 3001) employing two types of liquid electrolyte (1M $LiPF_6$ in 2 component and 3 component solvents). Furthermore, in order to decouple the contribution of anode and cathode of the 18650 full cell to its internal resistance, we fabricated half cells and symmetric cells (CR2016 type coin cells) for the corresponding cathode and anode by extracting them from the 18650 cells at various Depth of Discharge (DOD) and investigated their impedance. Among several polarization processes that occur within 18650 cell affecting its internal resistance and hence heat generation, the contribution of electrolyte seems to be significant. We report here how the choice of electrolyte in lithium titanate cells influences the internal resistance and thus their rate performances.

References:

[1] J. Hong, H. Maleki, S. Al Hallaj, L. Redey, and J. R. Selman, "Electrochemical-Calorimetric Studies of Lithium-Ion Cells (T)," vol. 145, no. 5, 1998.
[2] B. Manikandan, C. Yap, and P. Balaya, "Towards Understanding Heat Generation Characteristics of Li-Ion Batteries by Calorimetry, Impedance, and Potentiometry Studies," *J. Electrochem. Soc.*, vol. 164, no. 12, pp. A2794–A2800, 2017.
[3] P. Balaya and S. Hariharan, production of nanostructured Li4Ti5O12 with superior high rate performance, US9327990 B2